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INTERGLACIAL OSTRACODES FROM WASA MAYU, BOLIVIA

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SINOPSE

Ostracodes límnicos interglaciais são registrados pela primeira vez para as camadas de Wasa Mayu, Bolivia. Novas espécies são descritas e é discutido o paleo ambiente.

ABSTRACTS

For the first time limnic interglacial ostracodes are registered for the layers of Wasa Mayu, Bolivia. New species are described and discussed the paleoecolo gical environment.

1-INTRODUCTION

The material under study was received from Dr. Kurt Graf of the Geographisches Institut der Universität Zürich who studied the palinological data of the Quaternary of Bolivia. The wells (BC-25 and BC-23) from which proceeds the material was produced by the "Integrated UN and GEOBOL project for water prospection". The material came from the Well BC-25 at the Wasa Mayu area (17º32'S 65º49'W), at the following depths: 148, 157, 172, 186, 200, 212, 224, 236 and 248m; and from the Well BC-23, at Chala Conto area (17º34'S 65º56'30''W), at the 111m depth (Fig.1). The Wasa Mayu profile does not contain ostracodes in the upper 145m; there is gravel or sandy material. There is sandy clay material below 148m, from which came the ostracodes (Graf, personal communication).

The purpose of this paper is to describe and illustrate the succession of ostracodes in the Wasa Mayu profile trying to know the paleoecologic environment.

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3-GENERAL CONSIDERATIONS

The analysis of a small collection of limnic ostracodes of the last interglacial period from Bolivia, is of interest because little or almost nothing is known about such fossils in the Quaternary of that Country.

In spite of the material has been not well preserved, some interesting data was obtained.

At the first glance it is seen that *Limnocythere* strongly dominate the faunule in all levels. This predominance bring us to analise in detail the occurrence of this genus in South America. It has been described from Lago Titicaca, Bolivia, *Limnocythere titicaca* Lerner-Seggev, 1973; from Chile *L. arturi* Löfler, 1961 and *L. atacamae* Brehm, 1935; from Peru, *L. elongata* Delachaux, 1928 and *L. marshi* Brehm, 1924; from Uruguay *L. neotropica* Klie, 1934; from Argentina *L. paranensis* Ferguson, 1967. All these species belong to a recent freshwater faunule and even did not correspond to the species under study. Otherwise, faunules with the same characteristics of that one studies, (assemblages with abundant limnocytherids, few cypridids and no other forms) were analysed.

This kind of assemblage is assigned by Lerner-Seggev (op.cit.) for two samples at 40cm depth in the water edge of Lake Titicaca, near Huarina, Bolivia. This living faunule of ostracodes is formed almost entirely of *Limnocythere titicaca* and only two specimens each of *Darwinula* sp. and *Candona* sp.

Similar occurrence was registered for the 42m core sediments of Lake Cochise (late Pleistocene) by Cameron & Lundin (1977) where predominate specimens of *L. robusta* Delorme, 1967 and *L. pterygoventrata* Dickinson & Swain, 1967; *L. ceriotuberosa* Delorme, 1967 and *L. staplini* Gutentag & Benson, 1962, occur in any abundance, while all other species (Cypridids) collectively constitute less than 1 percent of the entire faunule. Cameron & Lundin (op.cit.) believe also that their Zone 3, with predominance of *L. staplini* , represents an interglacial zone.

Another very interesting paper is that of Dickinson and Swain (1967) about freshwater ostracoda and cladocera from Late Cenozoic of Northeastern Nevada where is refered, beside the presence of Cyprididae and Limnocytheridae, the occurrence of ephippium of *Daphnia?humboldtensis* Dickinson & Swain in the Middle and Upper Humboldt Formation. Similar material of cladoceran ephippia was found in the material under study at 186 and 200m of Wasa Mayu well.

4-CONCLUSIONS

Assemblages like that one of Wasa Mayu formed only by new species, do not permit a full correlation with other places but based in the distribution and abundance of the species through the core, it could be possible to obtain some interesting data. So, in spite of the small quantity of material which did not permit a definite conclusion Fig. 2 shows (through the stratigraphic distribution of the ostracodes available by the authors), that the lower part is reacher in species as in specimens than the upper part. It is observed also that there is a regular increase of ostracodes from the lower to the upper part of the interval, reaching to a maximum development of Cypridids as *Limnocythere variabilis* sp.nov. at 236m and of *L. grafi* sp.nov. and *L. jobimi* sp.nov. at 224m. Soon it is seen the decrease of the number of ostracodes that reaches the minimum number at approximately 212m, except the scarce number of Cypridids that occurs before. Another increase of forms occurs, and this number is maintained, more or less stationary, for a period of time. Finally, the

number decreases rapidly and the ostracodes disappear at 148m. The interval could be divided in two "zones", corresponding approximately the zones I and II of Graf's paper, obtained through the palinological study. Zone I (from 248m to 212m - lower part) has a strong dominance of *L. jobimi* and *L. variabilis*, and a moderate occurrence of *L. grafi* and Cypridids. Zone 2 (from 212m to 148m - upper part) has a very few quantity of Cypridids (only at 200 and 186m) and a regular occurrence of *L. jobimi*, *L.variabilis* and *L. grafi*.

The data obtained through the study of ostracodes, practically corresponds to Graf's interpretation (1977), which was based on pollen analysis, dividing this interglacial stage (B) in two parts (fig. 2). The lower part (I) represents an interval with wet and warm conditions, while the upper one (II) presents an slow increase of xerophilous plants pollen: *Compositae tubuliflorae*, *Chenopodiaceae* and *Amaranthaceae*. Through the graphic made by Graf, this reverse of the climate is represented at approximately 200m. Based on the ostracodes studied this reverse occurred apparently a little down (around 212m).

The occurrence of *Limnocythere*, cypridids and cladoceran ephippia suggests a lacustrine deposit. The carapaces do not seem to be selected according to size or development stages because immature carapaces are found together with adult specimens in all studied levels. This fact suggests a life assemblage, a paleobiocenosis.

From Cala Conto, it was received only one sample, at the 111m depth. This sample presents *L. variabilis* and *L. jobimi*. Unfortunately, with only one sample from this well, it is impossible to make any correlation with the Wasa Mayu Well. However, it will be interesting to check the possibility of a fault between them because in Wasa Mayu the highest place with these two species of ostracodes is at 157m while in Cala Conto it is at least at 111m depth.

5-SYSTEMATIC DESCRIPTION

Phylum ARTHROPODA
Sub Phylum Mandibulata
Classis Crustacea
Sub Classis Ostracoda Latreille, 1806
Ordo Podocopida Müller, 1894
Sub Ordo Podocopina Sars, 1865
Super Familia Cytheracea
Familia Limnocytheridae Klie⁻, 1938

Genus *Limnocythere* Brady, 1868

Diagnosis
Carapace thin, horny, with reticulate, tuberculate, or spiny surface. Marginal areas broad, with numerous straight radial porecanals; adductor scars 4, with crescentic antennal and oval mandibular scars in front and additional scars above.
Type-species: *Cythere inopinata* Baird, 1843

Limnocythere grafi Purper et Pinto, sp.nov.
Pl.1, fig.1-10

Derivatio nominis: in honour of Dr. Kurt Graf of Geographisches Institut der Universität Zürich.
Holotypus: female carapace M.P.,UFRGS nºMP-O-639
Paratypi: male, female and juvenile instars: MP-O-640 to 644
Locus typicus: Well BC-25 Wasa Mayu, Bolivia (200m depth)
Stratum typicum: Pleistocene

Diagnosis - Very large size, with a wide flat band all over the marginal zone and an elevated process followed by a strong sulcus on the ventral posterior lateral portion.

Description:
Female: Carapace subrectangular in lateral view; greatest height longer than half the length, being located at 1/4 of the length; dorsal margin almost straight bending backward; ventral margin concave at mid-length; anterior margin broadly rounded forming dorsally a distinct anterior cardinal angle; posterior margin truncated Distinct wide flattened band all over the free margin. Surface reticulate. Two sinuous transverse furrows in the anterior half; posterior furrow the longest, exceeding the mid-height. Between the two furrows, two nodes being the upper one the biggest. On the ventral posterior lateral portion an elevated process followed by a strong sulcus. In dorsal view carapace subelliptical, narrowly pointed anteriorly, narrowly rounded posteriorly. Greatest width slightly behind the middle, about 1:2,5 of the length. Valves approximately equal in size. Adductor muscle scars four in number, arranged in a vertical row. Other internal features not possible to be observed.

Male: Carapace larger than the female; more elongate, with dorsal margin straight not bent backward; anterior margin semi-circular, not forming a distinct cardinal angle with the dorsal margin; posterior margin narrowly rounded. In dorsal view subrectangular, with sides almost parallel, about 1:3 of the length.

Dimensions:
Holotypus: Female carapace MP-O-639. Length:0,961mm; height:0,506mm; width:0,404mm
Paratypi: Male carapace MP-O-640. Length:1,012mm; height:0,455mm; width:0,354mm
Female carapace MP-O-641. Length:0,961mm; height:0,506mm; width:0,328mm
Male carapace MP-O-642. Length:1,037mm; height:0,531mm; width:0,404mm
Juvenile instar MP-O-643. Length:0,759mm; height:0,430mm
Juvenile instar MP-O-644. Length:0,784mm; height:0,430mm; width:0,328mm

Remarks:
This species is distinguished from all other species of *Limnocythere* for its large size, presence of the wide flattened band all over the free margin and by the strong sulcus before the elevated lateral process on the postero-ventral portion.

Ocurrence:
From 148 to 248m of the Well BC-25, Wasa Mayu, N of Punata, Valle Alto de Cochabamba, Bolivia.

Limnocythere jobimi Purper et Pinto, sp.nov.
Pl.2, fig.1-14

Derivatio nominis: in honour of Prof. Dr. Homero Sõ Jobim, former Rector of the Universidade Federal do Rio Grande do Sul who gave strong support to research.
Holotypus: female carapace M.P.,UFRGS nº MP-O-645
Paratypi: males, females and juvenile instar: MP-O-646 to 651
Locus typicus: Well BC-25 Wasa Mayu, Bolivia (172m depth)
Stratum typicum: Pleistocene

Diagnosis - Subrectangular shape, male and female with dorsal margin straight; central part of the ventral margin of the female re-entrant and straight. Ventral lateral portion sweeling backward until 2/3 of the length and flattening posteriorly.

Description:
Female: Carapace subrectangular in lateral view; greatest height almost equal to half the length, being located at 1/5 of the length; dorsal margin straight; ventral margin rounded anteriorly and posteriorly presenting medially a straight re-entrance. Ventral portion swelling backward until 2/3 of the length and flattening posteriorly. Anterior and posterior margins rounded. Surface well reticulate. Two irregular transverse furrows in the anterior half; the anterior one faint and the second one deep,

long, exceeding the mid-height. Between the two furrows two nodes being the upper one the biggest. In dorsal view carapace elongate, narrowing forward and backward. Greatest width in the middle, about 1:3 of the length. Two furrows in front of the greatest width, the posterior one the strongest. Valves approximately equal in size. Adductor muscle scars four in number, arranged in a vertical row. Other internal features not possible to be observed.

Male: Greatest height slightly bigger than half of the length, being located at the posterior 2/3 of the length. Ventral margin sinuous, the posterior half with a big convexity, anterior half almost straight. Dorsal margin with very small re-entrances just on the furrows levels. Other characteristics same as the female.

Dimensions:
Holotypus: Female carapace MP-O-645. Length:0,683mm; height:0,328mm; width:0,202mm
Paratypi: Male carapace MP-O-646. Length:0,657mm; height:0,328mm; width:0,202mm
Juvenile instar MP-O-647. Length:0,531mm; height:0,278mm; width:0,177mm
Female carapace MP-O-648. Length:0,607mm; height:0,278mm; width:0,202mm
Male carapace MP-O-649. Length:0,657mm; height:0,354mm; width:0,227mm
Male carapace MP-O-650. Length:0,759mm; height:0,379mm; width:0,253mm
Female carapace MP-O-651. Length:0,607mm; height:0,278mm; width:0,202mm

Remarks:
The comparison of this species with other species is very unusual because in some instance they could be compared not with the correspondent sex but with the opposite one. Between two species sometime the males are very similar but the females are completely different. In other cases, the male of one is similar to the female of other species but the corresponding, female and male, has nothing in common.
So, in this case, the female of the new species is similar to the male of *L. staplini* Gutentag & Benson, 1962 having only the antero ventral portion less pronounced but the male differs completely from both sexes of *L. staplini*. The male of *L. jobimi* sp. nov. could be compared also with the male of *L. trapeziformis* Staplin, 1963 but this last one has deeper furrows, has nodes and the antero-ventral margin surpass the dorsal line. The female is not comparable.

Ocurrence:
From 157 to 248m of the Well BC-25, Wasa Mayu, N of Punata, Valle Alto de Cochabamba, Bolivia.

Limnocythere variabilis Purper et Pinto, sp.nov.
Pl.3, fig.1-14

Derivatio nominis: for the great variability of the carapace shape.
Holotypus: female carapace M.P.,UFRGS nº MP-O-652
Paratypi: males, females and juvenile instar carapaces: MP-O-653 to 658
Locus typicus: Well BC-25 Wasa Mayu, Bolivia (224m depth)
Stratum typicum: Pleistocene

Diagnosis - Dorsal margin arched, two nodes in front of the furrow, the upper one the largest.

Description:
Female: Carapace subreniform in lateral view, greatest height longer than half the length, being located just in front of the middle; dorsal margin arched merging smoothly to the rounded anterior margin, forming a feeble angle posteriorly; posterior margin subtruncated. Surface reticulate. Two irregular transverse furrows in the anterior half; the posterior exceeds the mid-height and it is deeper and longer than the anterior furrow. Between the two furrows, two nodes being the upper one the

greatest. On the latero-postero ventral region a swelling which reaches 3/4 of the length. In dorsal view subelliptical ending anteriorly in a blunt point and in an acute point posteriorly; two light furrows in the anterior portion; greatest width almost 1:2,4 of the length just behing the middle. Valves approximately equal in size. Adductor muscle scars four in number, arranged in a vertical row. Other internal features not possible to be observed.

Male: Carapace more elongate than the female; dorsal margin evenly arched; posterior margin subtruncate above and rounded below. Other characteristics same as the female.

Dimensions:
Holotypus: Female carapace MP-O-652. Length:0,683mm; height:0,379mm; width:0,278mm
Paratypi: Male carapace MP-O-653. Length:0,733mm; heigth:0,328mm; width:0,278mm
Juvenile instar MP-O-654. Length:0,581mm; height:0,303mm; width:0,202mm
Female carapace MP-O-655. Length:0,683mm; height:0,379mm; width:0,278mm
Female? carapace MP-O-656. Length:0,607mm; height:0,303mm; width:0,227mm
Female carapace MP-O-657. Length:0,708mm; height:0,379mm; width:0,278mm
Male carapace MP-O-658. Length:0,708mm; height:0,328mm; width:0,278mm

Remarks:
This species presents great variability in the carapace shape. The postero dorsal margin can run smoothly to the posterior margin or presents a truncation near the postero cardinal angle. This truncation can be faint or strong (pl.3, fig.10). The upper node can also present variation in size, reaching a very strong development (pl.3, fig.8). The female of *L. variabilis* sp.nov. can be compared to the female of *L. staplini* Gutentag & Benson, 1962 but the last one presents a slight sinuosity in the central dorsal region, just after the middle. The dorso anterior portion of *L. variabilis* is more bent downward than in *L. staplini*. The male can not be compared.

Ocurrence:
From 148 to 248m of the Well BC-25, Wasa Mayu, N of Punata, Valle Alto de Cochabamba, Bolivia.

Super Familia Cypridacea Baird, 1845
Familia Cyprididae Baird, 1845
Sub Familia Cypridinae Baird, 1845

Genus *Heterocypris* Claus, 1893

Diagnosis:
Carapace smooth, elongate. Valves unequal, the left one being the larger and overlaping the right. Free margin on the right valve crenulate with a row of tubercles and lacking the gibbosity of the dorsal border.
Type-species: *Cypris incongruens* Ramdohr, 1808

Heterocypris? cochabambaensis Purper et Pinto, sp.nov.
Pl.4, fig.1-6

Derivatio nominis: in reference to Cochabamba region
Holotypus: adult carapace M.P. UFRGS nº MP-O-661
Paratypi: adults and juvenile instars MP-O-659/660
Locus typicus: Well BC-25 Wasa Mayu, Bolivia (236m depth)
Stratum typicum: Pleistocene

Diagnosis - Greatest height just behind the middle. Ratio length/width around 2.65. Right valve with the postero-ventral margin crenulate.

Description:
Carapace suboval in lateral view; greatest height bigger than half the length, being located just behind mid-length; dorsal margin convex; ventral margin almost straight; anterior margin narrowly rounded; posterior margin more broadly rounded. Left valve slightly larger than the right. Right valve crenulate posteriorly. In dorsal view oval-elongate, the greatest width around the middle portion, having the ratio length/width around 2.65. Anterior extremity tapering gradually, ending in an acute point; posterior extremity obtusely rounded. Surface smooth. Other internal features not possible to be observed.

Remarks:
It differs from *Cyprinotus* by the lacking of the dorsal characteristic gibbosity of this genus. It differs from *Cyprinotus* and *Heterocypris* because the ratio length/width of these genera varies from 1.90 to a maximum of 2.43, while that of the specimen studied varies from 2.64 to 2.66.
Despite the new species presents a different length/width ratio which distinguishes it from all other *Cyprinotus* or *Heterocypris* already known, it will be not fair to create a new genus based in only one species with a such small difference. So, it is put in *Heterocypris* question mark, because it has not the dorsal gibbosity.

Dimensions:
MP-O-659 Length:1,012; height:0,556; width:0,404mm
MP-O-660 Length:1,087mm; height:0,581mm; width:0,404mm
MP-O-661 Length:1,113mm; height:0,632; width:0,430mm

Ocurrence:
From 248 to 224m of the Well BC-25, Wasa Mayu, N of Punata, Valle Alto de Cochabamba, Bolívia.

Sub Classis Branchiopoda Calman, 1909
Sub Order Cladocera Calman, 1909
Familia Daphnidae Straus, 1820

Genus *Daphnia* O.F. Müller, 1785

Daphnia (*Ctenodaphnia*) aff. *D. humboldtensis* (Dickinson & Swain), 1967
Pl.5, fig.1-6

Description - Specimen MP-M-262 (Pl.5, fig.1-3)
Ephippium podlike, elongate, slightly eroded anteriorly; dorsum straight; anterior margin oblique, straight dorsally, bending to a rounded truncate anterior portion, continuing with the broadly rounded venter; posterior margin sharply pointed just at mid-height. Marginal fringe all over the ephippium, larger ventrally. Two eggs locules roughly tandem and parallel to the dorsal margin. In dorsal view oval elongate, compressed just in front of the middle, with the marginal fringe looking as a robust ridge, which is projected strongly anteriorly and posteriorly.

Description - Specimen MP-M-263 (Pl.5, fig.4-6)
It differs from the specimen MP-M-262 by being slender in dorsal view, having in lateral view the anterior margin pointed medially; the posterior margin pointed above the mid-height and is less height than the anterior specimen.

Dimensions:
MP-M-262 Length of a eroded specimen:1,065mm; height:0,506mm; width:0,379mm
MP-M-263 Length: 1,138mm; height:0,455mm; width:0,278mm

Discussion:
The two specimens described present some differences. Nevertheless they are put in the same species because it was not possible to verify in only two and incomplete specimens, the full characteristics and the eventual variations that could occur in a

population.
The ephippia closely resemble *Daphnia? humboldtensis* Dickinson & Swain, 1967 having only the dorsal margin straight, while those described by Dickinson & Swain are slightly convex upward.
It appears to belong to the subgenus *Ctenodaphnia* as was pointed out also by Frey (1962), who says: "*In the subgenus Ctenodaphnia the ephippium is elongate, with the two egg locules roughly tandem and parallel to the dorsal margin. In the subgenus Daphnia the ephippium is more nearly equidimensional, with the two egg locules roughly parallel to one another and at right angles to the dorsal margin*".

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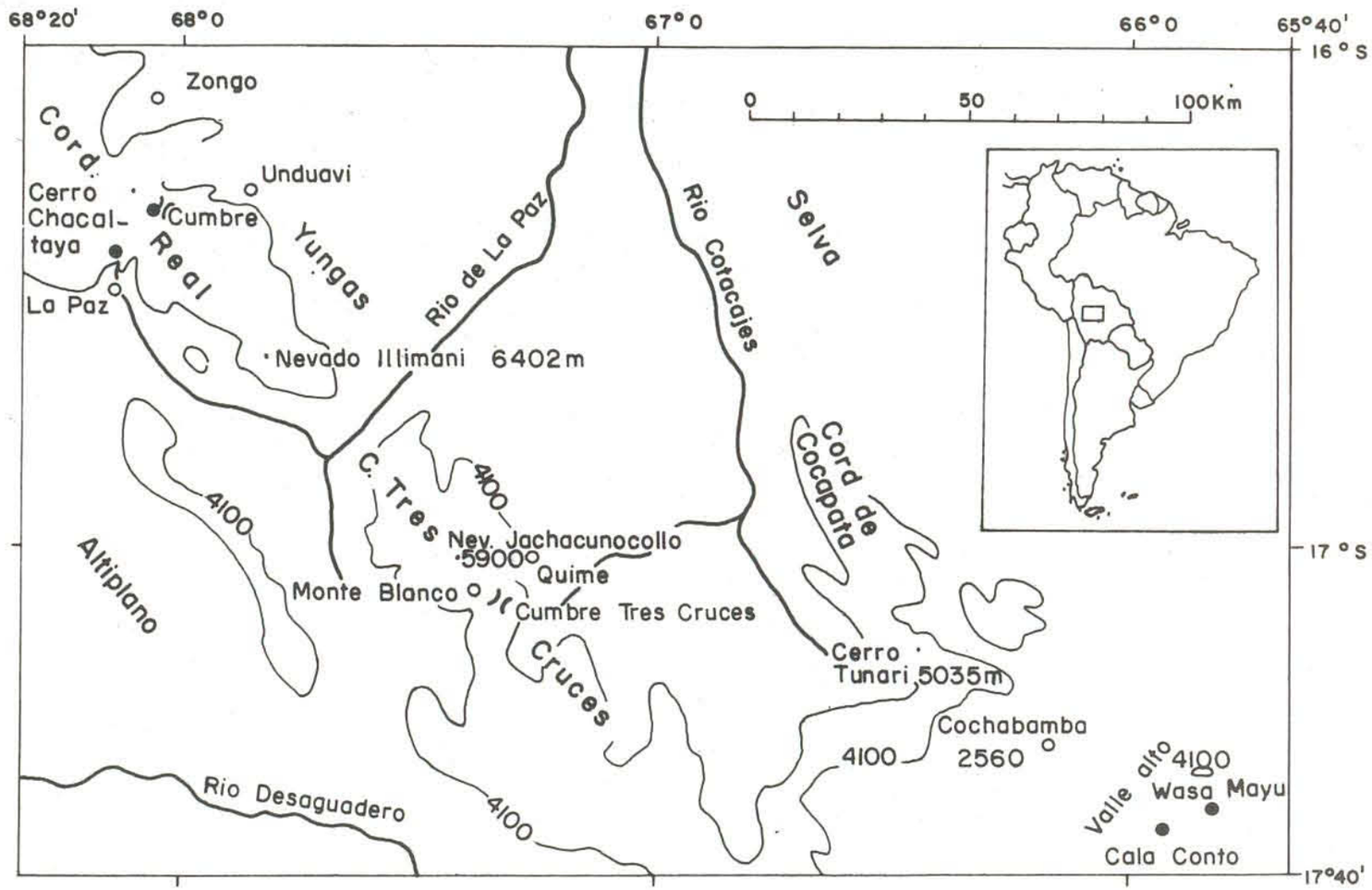

Fig. 1 Geographical position of the drillings
(Based in Kurt Graf, 1977)

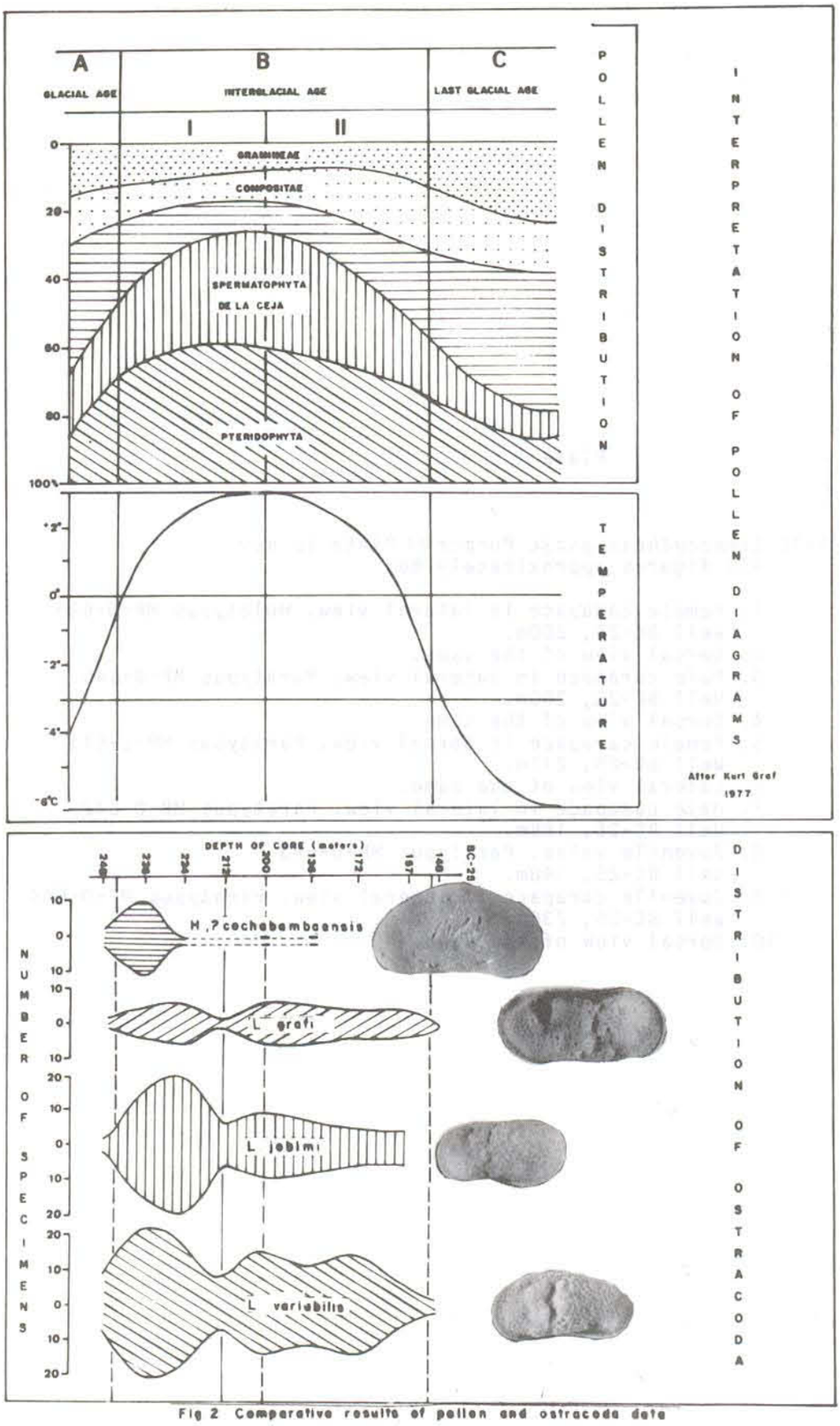

Fig 2 Comparative results of pollen and ostracods data

Plate 1

Fig. 1-10 *Limnocythere grafi* Purper et Pinto sp.nov.
All figures approximately 66x

1. Female carapace in lateral view. Holotypus MP-O-639
   Well BC-25, 200m.
2. Dorsal view of the same.
3. Male carapace in lateral view. Paratypus MP-O-640
   Well BC-25, 200m.
4. Dorsal view of the same.
5. Female carapace in dorsal view. Paratypus MP-O-641
   Well BC-25, 212m.
6. Lateral view of the same.
7. Male carapace in lateral view. Paratypus MP-O-642
   Well BC-25, 186m.
8. Juvenile valve. Paratypus MP-O-643
   Well BC-25, 148m.
9. Juvenile carapace in lateral view. Paratypus MP-O-644
   Well BC-25, 236m.
10. Dorsal view of the same.

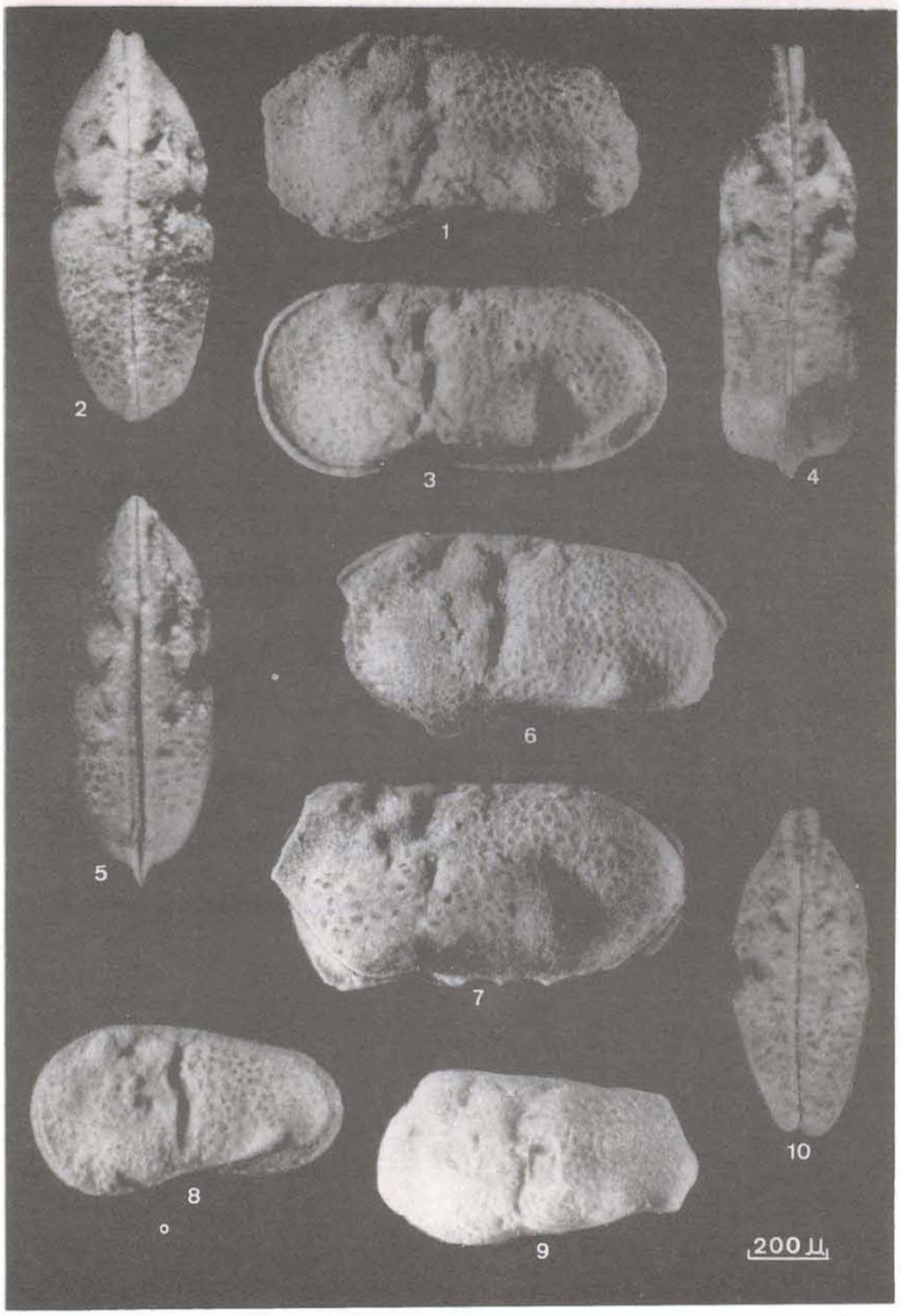
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Plate 2

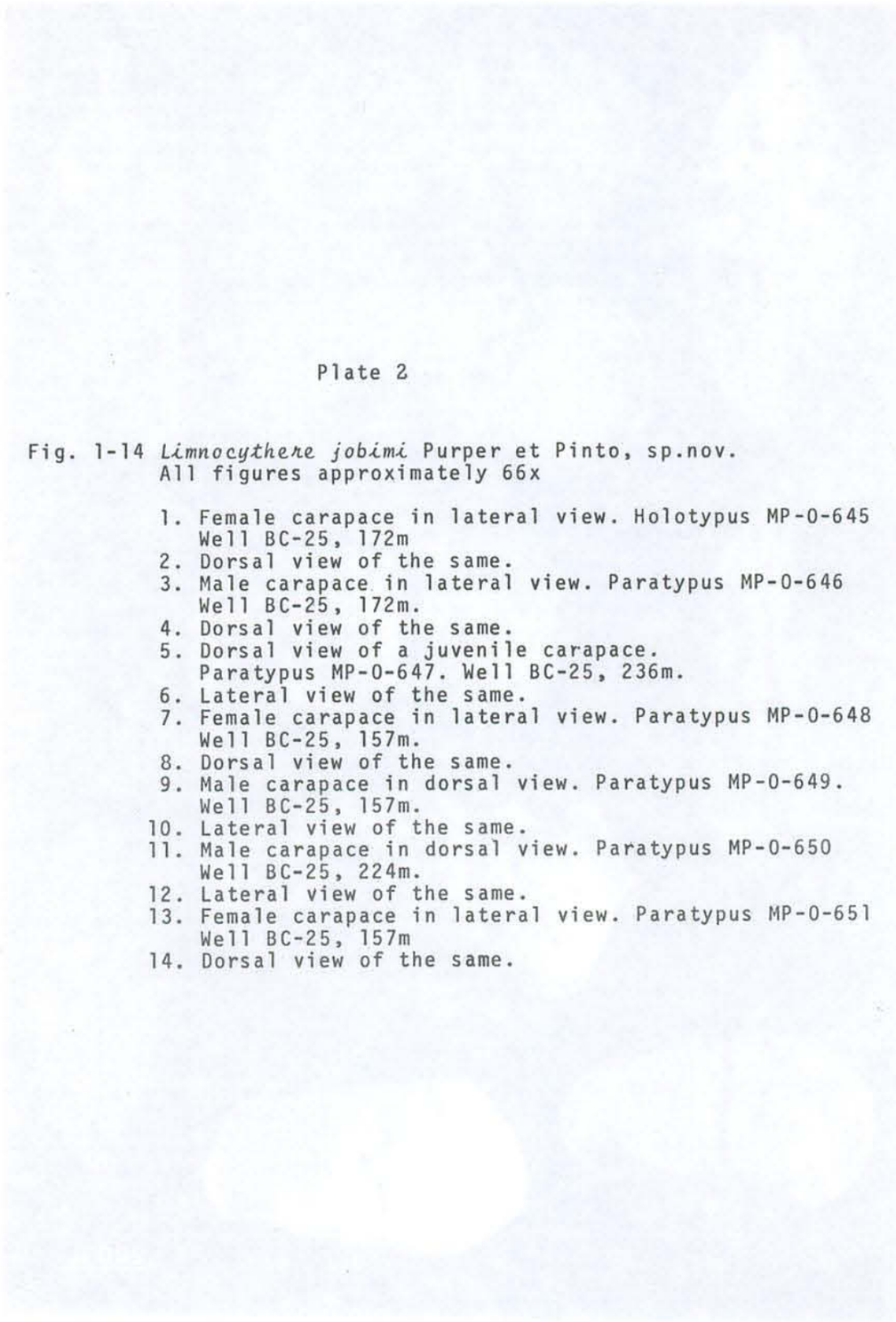

Fig. 1-14 *Limnocythere jobimi* Purper et Pinto, sp.nov.
All figures approximately 66x

1. Female carapace in lateral view. Holotypus MP-O-645 Well BC-25, 172m
2. Dorsal view of the same.
3. Male carapace in lateral view. Paratypus MP-O-646 Well BC-25, 172m.
4. Dorsal view of the same.
5. Dorsal view of a juvenile carapace. Paratypus MP-O-647. Well BC-25, 236m.
6. Lateral view of the same.
7. Female carapace in lateral view. Paratypus MP-O-648 Well BC-25, 157m.
8. Dorsal view of the same.
9. Male carapace in dorsal view. Paratypus MP-O-649. Well BC-25, 157m.
10. Lateral view of the same.
11. Male carapace in dorsal view. Paratypus MP-O-650 Well BC-25, 224m.
12. Lateral view of the same.
13. Female carapace in lateral view. Paratypus MP-O-651 Well BC-25, 157m
14. Dorsal view of the same.

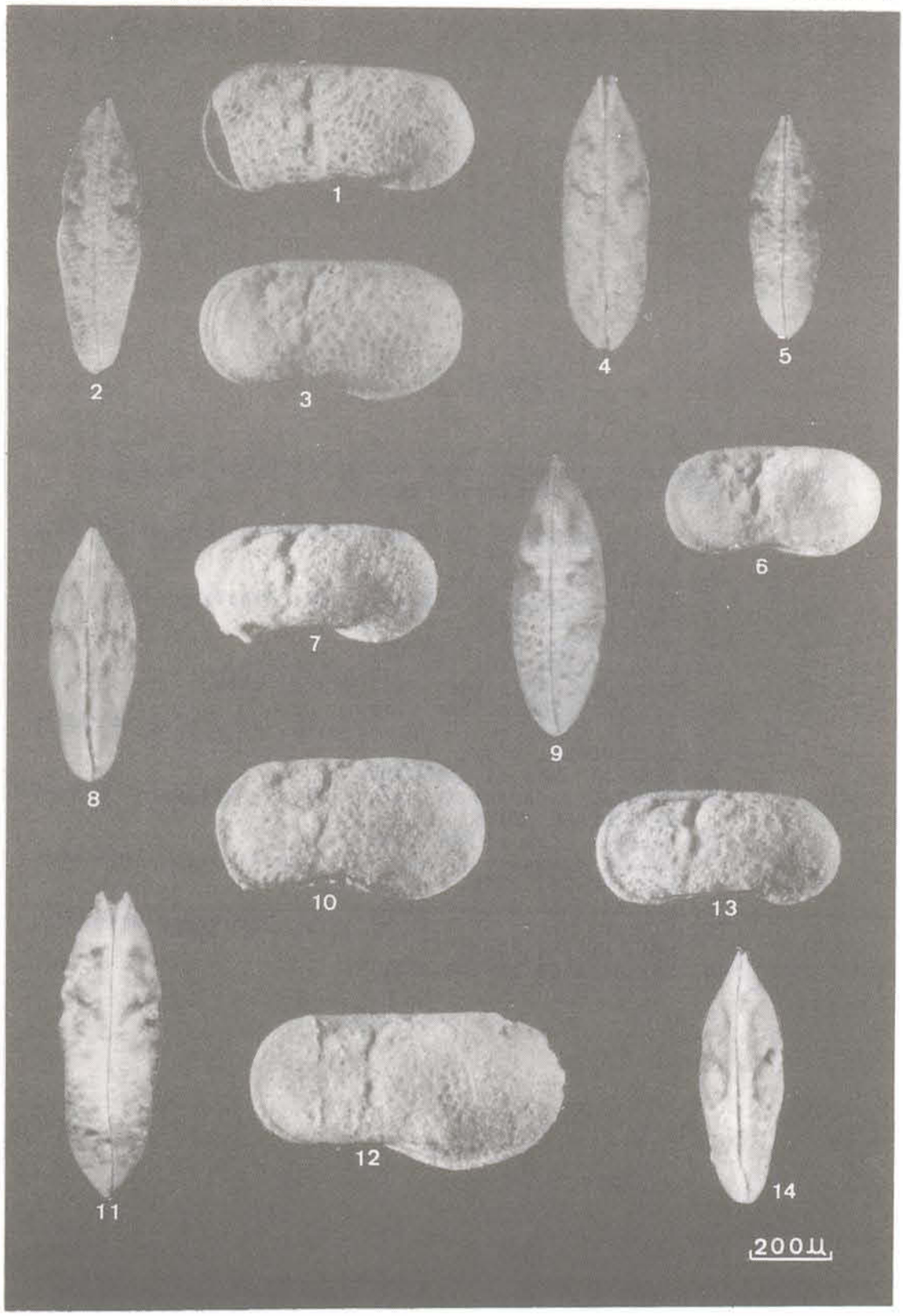
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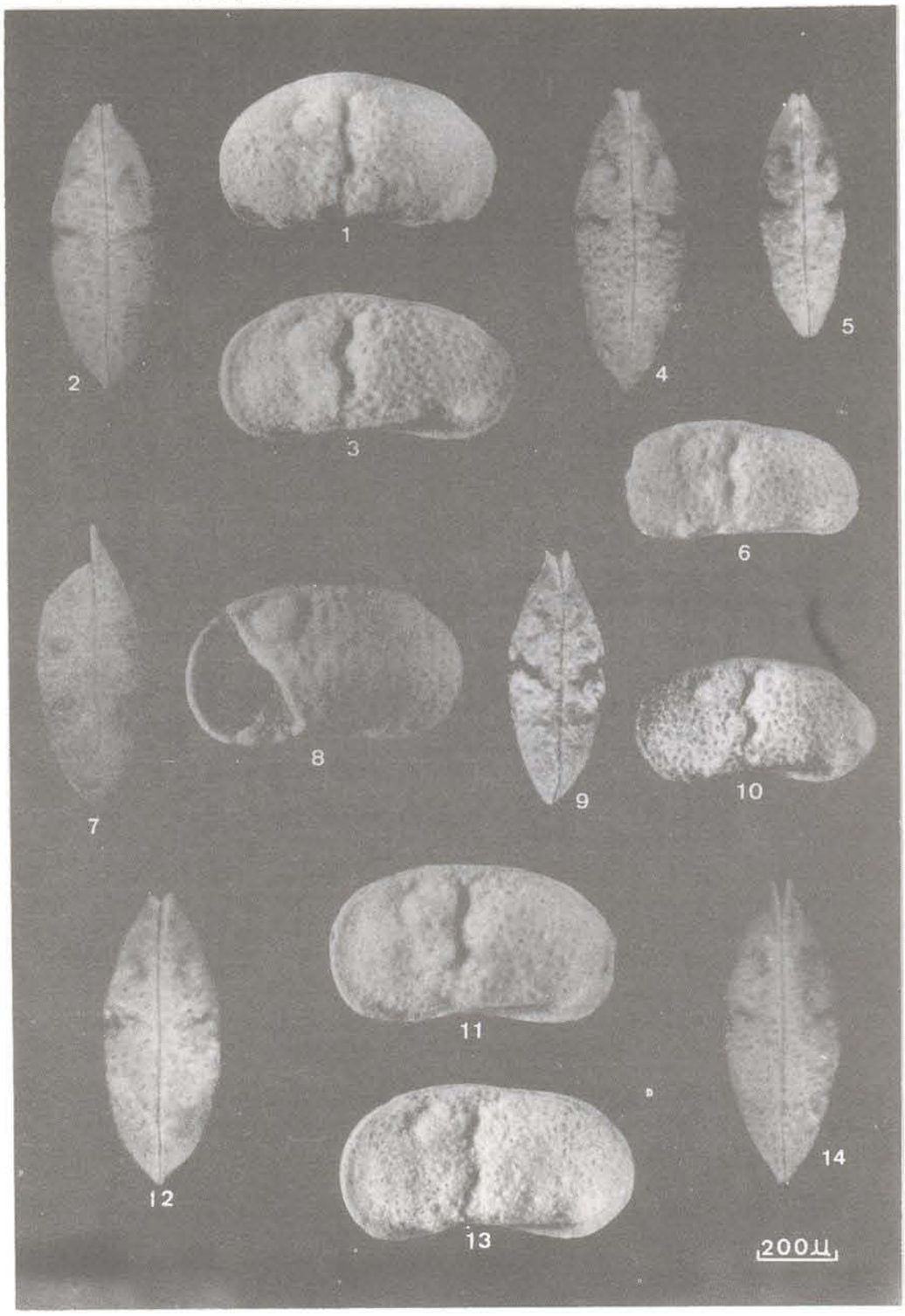
Plate 3

Fig. 1-14 *Limnocythere variabilis* Purper et Pinto, sp.nov.
All figures approximately 66x

1. Female carapace in lateral view. Holotypus MP-O-652. Well BC-25, 224m.
2. Dorsal view of the same.
3. Male carapace in lateral view. Paratypus MP-O-653. Well BC-25, 224m.
4. Dorsal view of the same.
5. Dorsal view of a juvenile carapace. Paratypus MP-O-654. Well BC-25, 212m.
6. Lateral view of the same.
7. Female carapace in dorsal view. Paratypus MP-O-655. Well BC-25, 172m.
8. Lateral view of the same.
9. Female? carapace in dorsal view. Paratypus MP-O-656. Well BC-25, 212m.
10. Lateral view of the same.
11. Female carapace in lateral view. Paratypus MP-O-657. Well BC-25, 224m.
12. Dorsal view of the same.
13. Male carapace in lateral view. Paratypus MP-O-658. Well BC-25, 224m.
14. Dorsal view of the same.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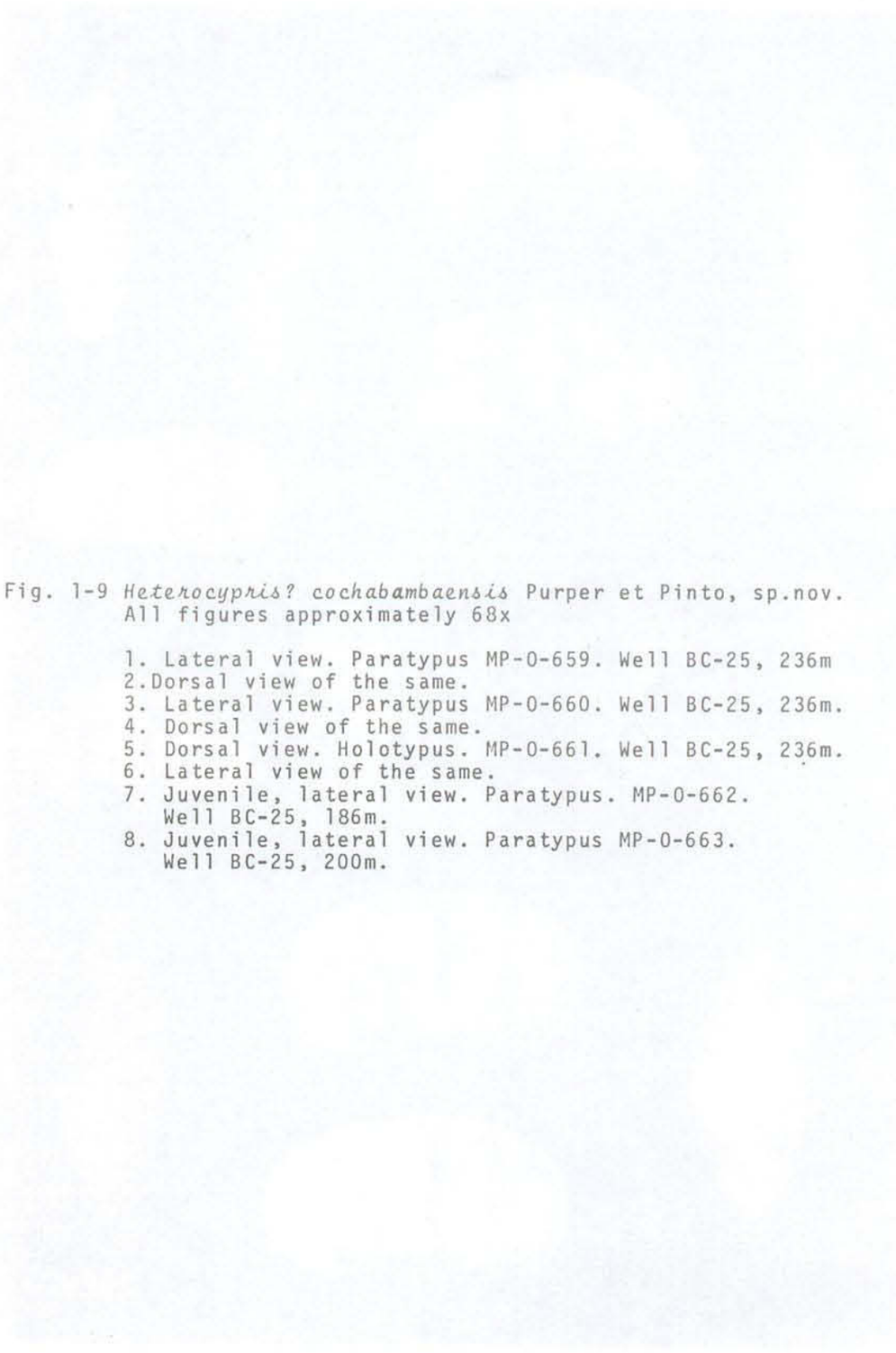

Fig. 1-9 *Heterocypris? cochabambaensis* Purper et Pinto, sp.nov.
All figures approximately 68x

1. Lateral view. Paratypus MP-O-659. Well BC-25, 236m
2. Dorsal view of the same.
3. Lateral view. Paratypus MP-O-660. Well BC-25, 236m.
4. Dorsal view of the same.
5. Dorsal view. Holotypus. MP-O-661. Well BC-25, 236m.
6. Lateral view of the same.
7. Juvenile, lateral view. Paratypus. MP-O-662. Well BC-25, 186m.
8. Juvenile, lateral view. Paratypus MP-O-663. Well BC-25, 200m.

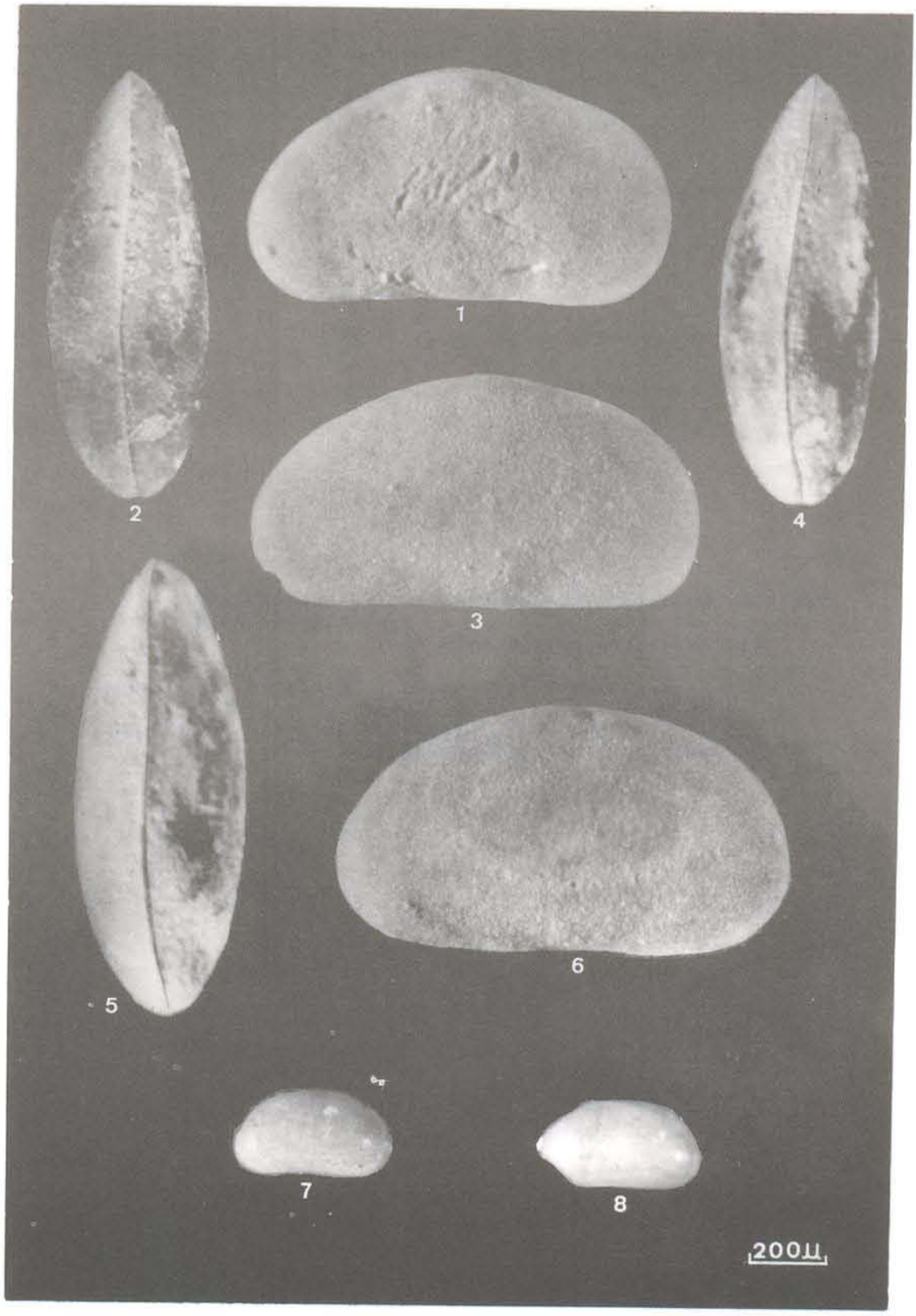
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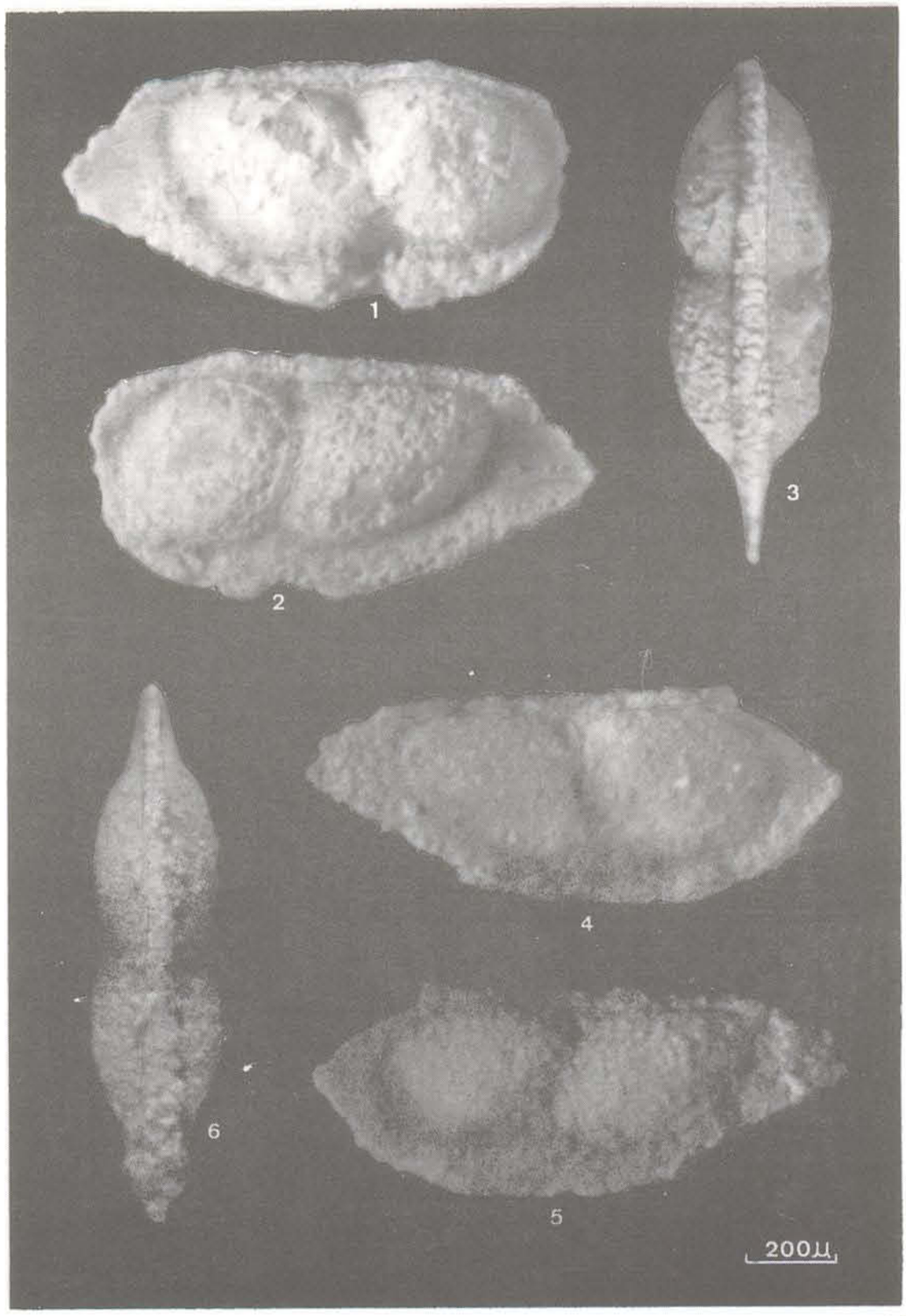
Plate 5

Fig. 1-6 *Daphnia? (Ctenodaphnia) aff. humboldtensis* Dickinson & Swain, 1967

All figures approximately 79x

1-3 Lateral and dorsal views of ephippia. Hypotypus MP-M-262. Well BC-25, 186m.

4-6 Lateral and dorsal views of ephippia. Hypotypus MP-M-263. Well BC-25, 200m.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